International Journal of Advance Research in Science and Engineering
Volume No. 14, Issue No. 03, March 2025
www.ijarse.com
IJARSE
ISSN 2319 - 8354

Automatic Rain Shield for Terrace Garden In Urban Areas

Prof. Vijaykumar Patil[1], Mr. Kalmesh Sonnad[2], Ms. Dipti Dodamani[3], Ms. Aishwarya Oulkar[4], Mr. Siddarth Daddi[5]

[1,2,3,4,5]Electronics and Communication Engg

Jain College of Engineering & Research, Belagavi, India

vijaypatil1135@gmail.com, kalmeshsonnad2@gmail.com, diptivd21@gmail.com, aishwaryaoulkar@gmail.com, siddharthdaddi5898@gmail.com

ABSTRACT

Urban terrace gardens are increasingly popular for their environmental benefits, aesthetic appeal and space opti- mization. However exposure to unpredictable weather conditions, particularly heavy rainfall can damage delicate plants, lead to soil erosion, and disturb carefully balanced moisture levels. The Automatic Rain Shield System aims to protect terrace gardens from heavy rain while maintaining a controlled microclimate. This system integrates rain sensors, a motorized retractable canopy and a microcontroller to detect rain intensity and auto- matically deploy a protective shield. When rain is detected beyond a threshold level, the rain sensor triggers the microcontroller to activate the motor, extending the canopy over the terrace garden. Once rainfall stops, the canopy retracts, allowing sunlight and fresh air to reach the plants. The system is energy-efficient oper- ating on solar power or a battery backup ensuring sustainability and functionality even during power outages. Remote control and manual override features add user flexibility while mobile app integration enables real-time monitoring. This rain shield system minimizes waterlogging, supports urban greenery, and promotes a healthy environment, making it an ideal solution for city dwellers with terrace gardens.

Index Terms—*Urban terrace gardens, Rain Shield, microcon- troller, arduino uno*

I. INTRODUCTION

Urban terrace gardening has emerged as a popular solution to maximize green spaces in densely populated cities, offering aesthetic, environmental, and social benefits such as improved air quality, urban cooling, and enhanced mental well-being. However, maintaining the health and productivity of urban terrace gardens is often challenged by unpredictable weather conditions, particularly excessive rainfall, which can damage plants, wash away soil and compromise the stability of the terrace structure. To address this issue, the implementation of an automatic rain shield presents a practical and inno- vative solution. This system is designed to protect terrace gardens from the adverse effects of heavy rainfall by providing real-time, responsive coverage. Through automated operation, the rain shield ensures that garden plants and soil remain undisturbed during unexpected downpours while minimizing manual intervention and labour costs. The system integrates weather sensors, automated mechanisms, and advanced con- trol technology to detect rainfall and respond in real time. Designed to be both durable and adaptable, the rain shield is customizable for different terrace sizes, plant types and urban layouts. It reduces the need for manual labour while ensuring consistent protection, enhancing the sustainability and viability of urban terrace gardening.

II. LITERATURE REVIEW

A comprehensive literature survey is conducted to explore existing research and scholarly articles pertinent to the study topic. The aim is to identify key themes, theories and findings that have shaped current understanding and to highlight any gaps or inconsistencies in the literature. This review provides a solid foundation for the research by situating it within the broader academic context, demonstrating its relevance and justifying the research approach. This study centers on creating an Automatic Sliding Door with an Infrared Sensor. The system consists of a sensor, control unit, and drive unit, facilitating automatic door operation in public building entrances. The primary goal is to comprehend automatic door system functionality and concepts, while the secondary goal is to build a basic circuit model showcasing the system's workings. This project includes sensors like an Infrared sensor to detect motion. A pressure sensor to detect the pressure occurred due to the weight of the person and it uses a Motion sensor to detect the motion of the people. Activities encompass studying automatic door operations, crafting a comprehensive circuit diagram, and constructing a functional model A comprehensive literature survey is conducted to explore existing research and scholarly articles pertinent to the study topic. The aim is to identify key themes, theories and findings that have shaped current understanding and to highlight any gaps or inconsistencies in the literature. This

review provides a solid foundation for the research by situating it within the broader academic context, demonstrating its relevance and justifying the research approach. This study centers on creating an Automatic Sliding Door with an Infrared Sensor. The system consists of a sensor, control unit, and drive unit, facilitating automatic door operation in public building entrances. The primary goal is to comprehend automatic door system functionality and concepts, while the secondary goal is to build a basic circuit model showcasing the system's workings. This project includes sensors like an Infrared sensor to detect motion. A pressure sensor to detect the pressure occurred due to the weight of the person and it uses a Motion sensor to detect the motion of the people. Activities encompass studying automatic door operations, crafting a comprehensive circuit diagram, and constructing a functional model This article focuses on the construction of a rain detection system that employs a rain sensor to recognize rainfall. It uses an Arduino and rain sensors to detect rain. The system works by establishing an interface with the rain sensor and controlling it using an Arduino UNO board. The Arduino Uno board serves as the microcontroller for a rain control module that is also used to regulate the movement of the sensor. The "Processing Development Environment Software" is then used to process the signal from the rain sensor in order to decide what is to be done. The automatic sliding window is a highly useful component in our daily lives and holds great significance in mechanical applications, particularly for the purpose of window opening and closing. This study aims to investigate the fundamental operational characteristics of the sliding window. To this end, a mechanically-based system for linear actuation and remote control was designed and constructed. This project encompasses various stages including design, fabrication, and assembly. It uses a limit switch to stop the movement of the window. Despite the existence of numerous sliding window types in the market, the completion of this new model offers enhanced practicality compared to its predecessors. This paper presents an Automatic Cloth Drying System using Rain and LDR

Sensors with an Arduino UNO. It addresses rain-related challenges during the rainy season when drying clothes outdoors. The fear of wet clothes due to rain prompts individuals to avoid open drying areas and use their home terraces instead. [5] To tackle this issue, the author proposes an automatic clothes line towing device. This device employs an Arduino Uno, rain sensor and Light Dependent Resistor (LDR) sensor. It operates by detecting weather conditions through these sensors. In the absence of light, indicating rain, the device moves the clothes line to a sheltered spot.

III. DESIGN AND IMPLEMENTATION

The proposed concept is structured in a way that the components selected during the design phase are the ones used to develop the proposed embedded system components utilized in the project are listed in Table 1 below.

TABLE I LIST OF COMPONENTS

Sl No.	Name	Specification	Quantity
1	Arduino UNO	ATmega328P	1
2	DC Motor	0.1A	1
3	Rain Sensor	0-100 mm	1
4	Buzzer	5V	1
5	LCD display	16 x 2	1
6	L298 Motor driver	2A	1
7	LED	10mm	1
8	Battery	3.7V	2
9	Battery slots	-	1
10	Connecting wires	-	As required

A. Arduino UNO

The Arduino Uno (Fig 3.1) is a highly popular microcon- troller board built around the ATmega328P microcontroller known for its versatility and ease of use. It operates at a voltage of 5V making it compatible with a wide range of sensors and modules. In board features 14 digital input/output pins, six of which can be used as PWM outputs, allowing for fine control of devices like motors and LEDs. Additionally, it includes six analog input pins for reading sensor data. The Arduino Uno offers a straightforward programming interface via the Arduino IDE, which supports a vast library of prewritten code for various applications. It has 6 analog input pins, labeled A0 to A5, which can read signals from analog sensors. The board also includes a power supply section with pins for 5V, 3.3V, Ground (GND) and VIN. The power pins enable the board to be powered either through a USB connection or an external power source. There are also pins for SPI communication (10, 11, 12, 13), I2C communication (A4, A5 for SDA and SCL) and UART serial communication (pins 0 and 1 for RX and TX). Furthermore, the Arduino UNO has a reset pin for restarting the program.

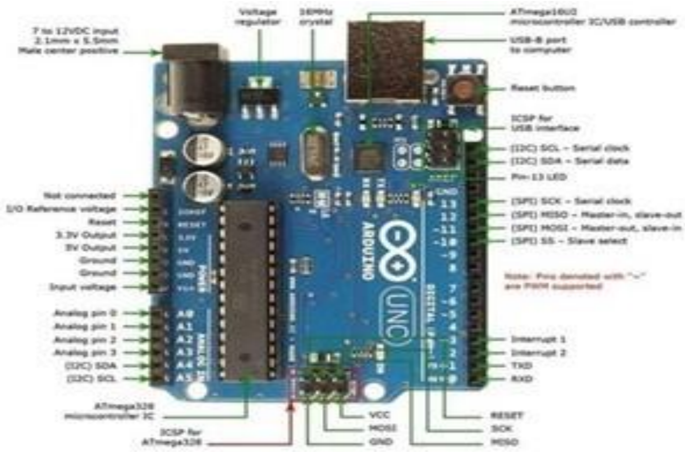

Fig. 1. Arduino UNO Microcontroller

B. DC Motor

The DC motor converts direct current (DC) electrical energy into mechanical energy, which is widely used for its simplicity and precise control. Fig 3.2 consists of a stator, which provides a constant magnetic field and a rotor (armature) that rotates within this field. The interaction between the magnetic field and the current in the rotor generates torque, causing rotation. Speed and direction can be controlled by varying the input voltage or current. There are many applications for DC motors, they can be used in robotics; electric vehicles, and some industrial machinery as well as household devices. DC motor can be used at such places where speed control is required.

Fig. 2. DC Motor

C. Micro-controller

A rain sensor is used to detect the rain. It detects rain in applications like irrigation, car wipers, and weather mon- itoring. It provides analog or digital outputs. Analog sensors give voltage/current proportional to rainfall, while digital ones signal rain's presence or absence. Some allow threshold ad- justment for the response. Rain sensors integrate into systems, adapting to scenarios. Calibration ensures accuracy and reli- ability by compensating for variations. Regular maintenance keeps sensors efficient. Key features of rainfall sensors in- clude signal conditioning, converting analog to digital values, amplifying operations and optimizing signals for processing. Rainfall sensor modules offer digital outputs for rain pres- ence/absence, interfacing with microcontrollers, development kits, and electronics for further operations. These modules are compatible with various microcontrollers and kits, utilizing common communication interfaces like I2C and GPIO pins for digital, and analog voltage output for analog interfaces.

A buzzer is an electromechanical or electronic device that produces a sound when activated. It is commonly used as an alert or signal in various applications, such as in alarm systems, timers, or interactive devices like quizzes and games. Buzzers operate by using electrical energy to create vibrations or air movement, producing a distinct and often loud sound to grab attention. In many cases, they are connected to a circuit, and when a specific event occurs like pressing a button, reaching a preset time, or triggering a sensor the circuit energizes the buzzer, causing it to sound. Buzzers are simple, cost-effective, and reliable, making them a popular choice in both industrial and consumer electronics.

Fig. 3. Rain Sensor

Fig. 4. Buzzer

IV. METHODOLOGY

Methodology refers to a systematic, structured approach or set of procedures used to conduct research, solve problems or archieve specific objectives. It encompasses the methods, techniques and principles employed to collect data, analyze information and draw conclusions. In essence, methodology outlines how a project or study is carried out, ensuring consistency and reliability in the process. Microcontroller (e.g, Arduino UNO or ESP32)-The microcontroller serves as the brain of the system. It processes input from the rain sensor and controls the actuation of the motor or mechanical arm. The microcontroller is well programmed to automate the opening and closing of the shield based on real-time weather data. Rain Sensor- The core of the system is the rain sensor, which detects precipitation levels. When rain is detected, the sensor sends a signal to activate the protective mechanism. It helps differentiate between light drizzle and heavy rain, ensuring the shield only deploys when needed. LED Indicator- The LED serves as a visual indicator for the system's status. It is programmed to light up in different colors to convey various signals. For instance, a green LED might indicate that the system is active and monitoring weather conditions, while a red LED could signal that the canopy is deploying due to detected rainfall. This visual cue helps users quickly understand the system's operation without needing to check the control interface. DC Motor-The DC motor is a key component responsible for the movement of the rain shield canopy. It provides the mechanical force needed to extend or retract the canopy based on signals from the microcontroller. When rain is detected by the sensor, the microcontroller activates the DC motor, which then moves the canopy into place to cover the garden. The motor's speed and direction is controlled precisely to ensure smooth operation, protecting the plants from heavy rainfall while allowing easy retraction when the rain stops.

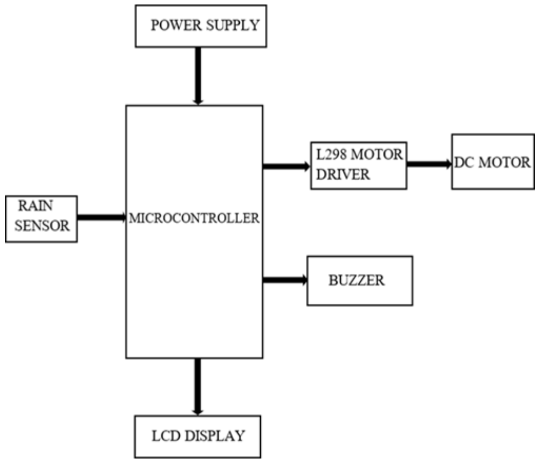

Fig. 5. Block Diagram

Buzzer -The buzzer is used as an audible alert system to notify users of specific events. For example:- When the rain sensor detects precipitation and the canopy starts to deploy, then the buzzer emits a short beep to alert nearby users. This warning sound can also be triggered if there are any issues with the system, such as motor malfunction or low battery power, providing an additional layer of feedback to ensure proper maintenance and quick response in case of faults.

V. HARDWARE IMPLEMENTATION

Creating a hardware implementation of an automatic rain shield for urban terrace gardening involves designing a system that can detect rainfall and respond by deploying a protective shield to safeguard the plants. The system requires a variety of hardware components such as Microcontroller (e.g. Arduino UNO or ESP32), Rain sensor, DC Motors, a pair of batteries, L298N Motor Driver, Buzzer, LED. The system involves inte- grating rain detection sensors, a control unit, and a motorized deployment mechanism. The system can be broken down into several key subsystems: Firstly a rain detection module, such as a resistive rain sensor or digital rain sensor to detect the presence of rain and sends a signal to a microcontroller. The microcontroller (e.g., Arduino UNO or ESP32) acts as the system's control brain. It then processes this signal and triggers a motorized shield system using motor driver ICs like L298N. The motor driver converts low-power logic signals from the microcontroller into high-power signals to drive the motor. It interfaces the microcontroller with the motor by managing current and power levels. The shield itself can consist of a rolling tarpaulin or sliding protective panels, deployed via DC motors, stepper motors or actuators, managed by the microcontroller. The DC motors could be used for simpler applications or stepper motors for more precision. Power is supplied by batteries or solar panels to ensure autonomy, while a pulley system or sliding track mechanism allows the shield to move over the terrace garden area. The system may also incorporate optional IoT connectivity for remote monitoring or manual control. This design allows urban gardeners to efficiently protect their plants from unexpected rain while optimizing space and responding quickly to weather changes. This system ensures the terrace garden remains protected from unexpected rainfall while maintaining an efficient and space- saving design for urban environments.

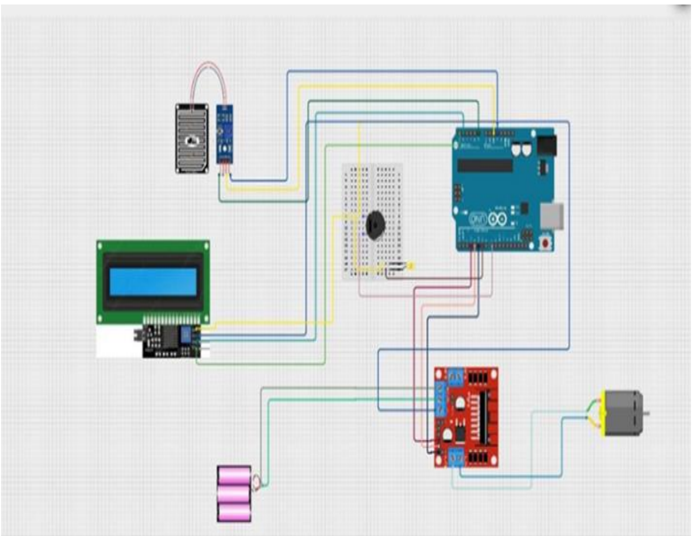

Fig. 6. Automatic Rain detection system

VI. RESULTS & DISCUSSION

The automatic rain shield system for urban terrace garden- ing was developed and tested to provide sufficient protection for terrace gardens during rainfall events while maintaining ease of operation and responsiveness. The automatic rain detection sensors (e.g., moisture, precipitation or water sen- sors) successfully triggered the system's shield deployment in response to rain events. The shield's deployment mechanism (e.g., motorized retractable covers) operated without mechan- ical failure showing durability and stability under variable weather conditions. No signs of wear or degradation were found after testing under sustained mechanical use or exposure to environmental factors such as heavy rain. The results of this study indicate that the automatic rain shield system is a viable, cost- effective and reliable solution for protecting urban terrace gardens from the effects of unexpected rainfall. The system's ability to reduce water penetration demonstrates its capacity to mitigate overwatering risks and safeguard vulnerable urban terrace plant systems during unpredictable weather. Sensor reliability was confirmed, with no false triggers observed

during testing. The system's mechanical reliability and ease of integration into existing urban terrace designs suggest that it can be scaled or customized for a variety of urban envi- ronments, including small balcony spaces. While the system showed promising results, it may be necessary to optimize for extreme weather conditions. Future studies could expand on testing the system under diverse climatic conditions or explore the use of alternative renewable energy sources to support its operation. The study demonstrates that the automatic rain shield system achieves the intended objectives of protecting urban terrace gardens with minimal user intervention while maintaining energy efficiency and mechanical durability. The results highlight its feasibility as a scalable solution for urban gardening environments, particularly in areas vulnerable to frequent or unexpected heavy rainfall.

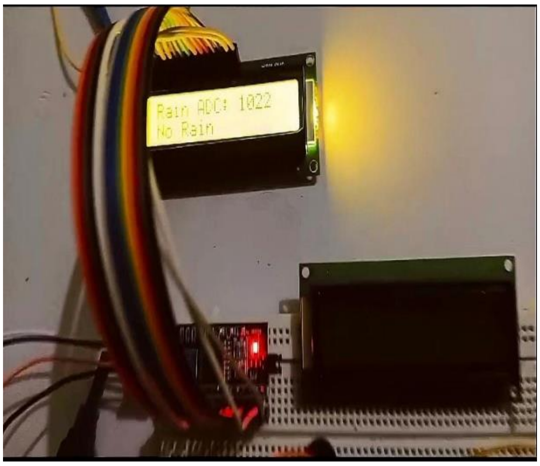

Fig. 7. Automatic Rain detection system

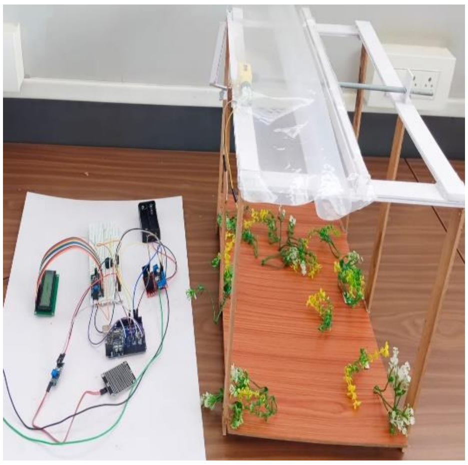

Fig. 8. Automatic Rain detection system

VII. CONCLUSION

The entire project presents a unique approach to building a smart roof that is very useful in our daily life. This project helps to address the problems faced by people by providing a solution to the problems faced due to unusual rains. This motorized smart roof helps the garden owners to protect their plants without any fear of getting the plants drenched. It also helps garden owners in preventing the losses that may occur due to unusual rains. This project detects the rain and makes the roof spread over the area with the help of IoT technology like using the rain sensor to detect the rain and motors to spread the roof. The constraints in this project can be overcome by using advanced technologies. Integration of the Motorized smart roof with the weather forecast enables the roof to adjust itself according to the weather conditions. This roof can also be integrated with Smart home automotive devices like Smart Grid, which further improves the performance. These solutions for the problem will make an efficient, sustainable and convenient method for the operation of the roof.

REFERENCES

[1] O.M. Oladumoye, Oluwatomi Adenike, "Design and Construction of Automatic Sliding Door using Infrared Sensor", CISDIAR, Vol. 5, 4,(2014)

[2] P. Sumit. Patil, Jignech. R. Dhabuwala and Liyakat Ali Patel, "Automatic Sliding Window",IJSR,(2015).

[3] T. Ram Mohan, Alister Varghese, S. Dineshbabu, N. Jayasakthiramand

D. Jagadeeshwaran, "Design and development of Automatic Retractable roof for clothesline with Notification System", IJPM, Vol.118,20,(2018)

[4] S. Yogesh, T.M Sreedhar and Ms. G. T. Bharathy, "Rain Detection System using Arduino and Rain Sensor", IJSRSET,(2021)

[5] Athaya Atsiq, Andryan Gunawan and Amin Alqudri Dwi Nu- graha,"Automatic Cloth Drying using rain sensors and LDR sen- sors based on Arduino Uno",Yayasan Inovasi Substantial Indonesia (SISIA),Vol. 1, 02,(2022)